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ELECTRIC TRANSMISSION LINE COSTS

AND

CONSTRUCTION LEAD TIMES

November 1984

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OTA WORKING PAPER

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ELECTRIC TRANSMISSION LINE

COSTS AND

CONSTRUCTION LEAD TIMES

Final Report
of
Office of Technology Assessment
Contract 233-7280.0

Submitted by:

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1000 Connecticut Avenue, N.W.
Washington, D.C. 20036

October 19, 1982

Table of Contents

	Page
Executive Summary	1
Introduction	4
Results	6
APPENDICES	
A Location of Transmission Lines Studied	10
B Rifle - San Juan 345KV Line Case Study	15
C Jackson's Ferry-Axton 765KV Line Case Study	18
D Perry-Hanna 345KV Lines Case Study	20
E Duval (Fla.) - Hatch (Ga.) 500KV Lines Case Study	23
F Elroy-Hosensack 500KV Line Case Study	27

EXECUTIVE SUMMARY

This study was commissioned by the Office of Technology Assessment to determine the potential for constructing new electric transmission facilities as one strategic response to a long-term major oil supply disruption. The primary considerations for implementing such a strategy are the time required to build new facilities (including licensing and construction phases) and the cost of construction.

In performing this work a number of newly completed and proposed transmission lines were surveyed. For each facility the electric utility responsible for construction of the line was contacted and, where possible, the following information was obtained:

- Line Description - including length, type of support structure and whether new or existing right-of-way was used.
- Cost - broken down by towers and conductors, terminal equipment, and right-of-way.
- Time Required for Licensing and Construction.
- Reasons for Delay in Completion or Accelerated Installation.

This information is provided in detail for each line in the individual case studies in Appendices B through F. From this information the following conclusions have been drawn:

Cost

Construction costs range from a low of $300,000 per circuit mile to a high of $1,030,000 per circuit mile. Some of the reasons for variations in construction costs are differences in tower design (possibly required for local aesthetic reasons), regional differences in labor costs, differing degrees in construction difficulty caused by area topography, and whether the utility purchases the land for the right-of-way or merely obtains an easement to cross a parcel of land.

Construction Time

Construction times for the lines surveyed ranged from a low of 14 months to a high of four years. Additionally, the time to build a transmission line is somewhat independent of length.

The time required for actual construction of the physical plant (towers, conductors, circuit breakers, etc.) is dependent upon construction techniques, the type of terrain (swamps, mountains, city, rural) over which the line must be built and, in some cases, the availability of construction equipment. As an example of the latter point, the use of heavy-lift helicopters in mountainous areas has greatly increased the speed at which transmission facilities can be built. If rental helicopters are not available, free standing cranes must be used with an increase in difficulty and construction time.

Licensing and Certification

The time required for licensing and certification ranged from one month to nine years for the transmission lines surveyed.

By far the single most time consuming phase of transmission line installation is the obtaining of appropriate certification for the line by state, local and, in some cases, federal authorities. In most states the actual procedures for certification or approval to construct a line are complex enough to significantly increase the total construction lead time of most projects. However, further delays are produced by various special interest groups which use the appeals process in an attempt to discourage completion of the line.

INTRODUCTION

During the past decade, the supply of oil to the United States has been interrupted several times. In various regions of the country (the northeast, southeast and west coast) electric utilities are heavily dependent upon the use of oil for the production of electricity.

One of the ways that electric utilities have been able to mitigate the effects of these relatively short-term oil disruptions is by generating electricity by burning coal in one region of the country and transmitting this electric power over the existing electric transmission system to supply load in adjoining regions of the country that are more heavily dependent upon the use of oil for generation.

The success with which electric power may be transferred from one region to the other (commonly referred to as "coal-by-wire") is largely dependent upon the existence of a transmission system capable of handing this increased flow of electric power. In the past where sufficient transmission capability did not exist, it was neither practical nor possible to install additional transmission lines in order to handle the short-term crisis. However, any response to a longer term major oil disruption (five years or more) could include the installation of additional bulk power electric transmission facilities which would increase the ability to transfer large amounts of electric power from coal rich regions to oil dependent regions.

In the last fifteen years, the time required to plan, license and construct high voltage electric transmission lines

has increased drastically. This increase in time has been due almost exclusively to the ever increasing administrative and legal requirements placed on the utilities during state, local, and Federal licensing procedures. In many cases an extremely complex and tedious licensing process has caused critical bulk power transmission lines to be delayed beyond their proposed and required in-service date.

The Office of Technology Assessment is presently studying the potential for the application of electric technologies in mitigating a major oil disruption. The building of bulk power electric transmission lines to displace oil fired generation in one region of the country with coal fired generation in another is one of the responses being considered. In order to determine the potential for the application of this coal-by-wire strategy, it is important that some of the practical considerations involved in the construction of transmission facilities be identified.

This report identifies some of the typical causes of delays in the installation of transmission facilities, as well as construction costs of transmission facilities and the amount of time required for actual construction after all licensing requirements have been fulfilled. It also provides a comparison with "rapid" construction times.

RESULTS

Case studies were developed for each of five existing and proposed electric transmission lines. The basis for line selection was that they are major additions to regional bulk power electric transmission systems and that they define the range of construction costs, construction times and licensing periods that most other transmission facilities would fall within.

The specific lines selected for this study are as follows:

Existing Lines

Elroy-Hosensack (500KV)	- Philadelphia Electric Company (Pennsylvania)
Duval-Hatch (500KV)	- Florida Power & Light Corp. and Georgia Power Company (Florida and Georgia)

Proposed Lines

Rifle-San Juan (345KV)	- Colorado-Ute Electric Association (Colorado-New Mexico)
Perry-Hanna (345KV)	- Cleveland Electric Illuminating Co. (Ohio)
Jackson's Ferry-Axton (765KV)	- Appalachian Power Company (Virginia)

(See Appendix A for the location of the endpoints of these lines.)

Each electric utility was contacted and asked to provide information on line description, construction cost, licensing procedures (including special problems or lack of problems)

and contruction times. This information was used in developing detailed case studies for each transmission line. Table I summarizes these findings. Appendices B through F contain the individual transmission line case studies.

In reviewing the information contained in this report, it is useful to understand some of the major steps required in the construction of transmission lines. The following list provides a general outline of some of the more important steps that most utilities follow when building a major transmission facility.

- o Planning for the line - includes a determination of capacity, location and timing.
- o Approval of construction expenditures by utility management.
- o Ordering of equipment.
- o Issuance of a Certificate of Public Convenience and Necessity by the State(s).
- o Completion and Approval of an Environmental Impact Statement.
- o Obtaining permits to construct line from all jurisdictions through which the line will pass.
- o Begin development of end point facilities
- o Obtain right-of-way by obtaining easements to cross land and/or purchase of land.
- o Clear right-of-way.
- o Set concrete footings for erection of towers.
- o Erect towers.
- o String conductors and insulators.
- o Energize, test, and place in service

TABLE I

SUMMARY OF TRANSMISSION LINE CONSTRUCTION DATA

	RIFLE-SAN JUAN	JACKSON'S FERRY-AXTON	PERRY-HANNA	DUVAL-HATCH	ELROY-HOSENSACK
STATUS	Proposed	Proposed	Proposed	Existing (2-lines)	Existing
STATE	Colorado-New Mexico	Virginia	Ohio	Georgia-Florida	Pennsylvania
VOLTAGE	345,000	765,000	345,000	500,000	500,000
CONDUCTOR SIZE	1272 MCM ACSR*	---	954 MCM ACSR*	1113 MCM ACSR*	2493 MCM ACSR*
LENGTH (Miles)	280	72	51 or 58	Fla: 36 Mi. each Ga: 1-90 Mi., 1-106 Mi.	17
RIGHT-OF-WAY (New/Old)	NEW	NEW	75% NEW	NEW	NEW
COST	$300,000-$350,000/Mi. (1982 $) (Total project cost $125,000,000 including 5 substations).	Approx. $800,000/Mi. (1985 $) (Line & Equipment - $56,000,000; Land for R/W $5,600,000)	Approx. $1,030,000/Mi. (Line = $45-$50 million; R/W = $ 5-$ 7 million; Terminal Equip. = $2.6 million in current 1982 dollars.)	Approx. $390,000/Mi. (Fla: Line=17,000,000 Total Subs=13,000,000 Total Ga: Line=67,000,000 Total Subs= 8,000,000 Total)	$15,000,000 (Including line and work at Elroy Substation).
CONSTRUCTION TIME	Estimated 24 months (Add'l. 6 mos.- 1 year for R/W Acquisition)	Estimated 3 years	Estimated 4 years (R/W acquisition to be concurrent with erection).	2 years (actual)	14 months
LICENSING TIME	5 years	8 years (Minimum, assuming favorable court ruling)	6 years (Minimum, assuming favorable court ruling)	Approx. 1 month	9 years (Litigation by private citizen delayed possible in service date 7 weeks.)
ORIGINAL/PRESENT IN-SERVICE DATE	1982/1985	1977/1985	1985/1988	1983/1982 (actual)	1974/1981 (actual)

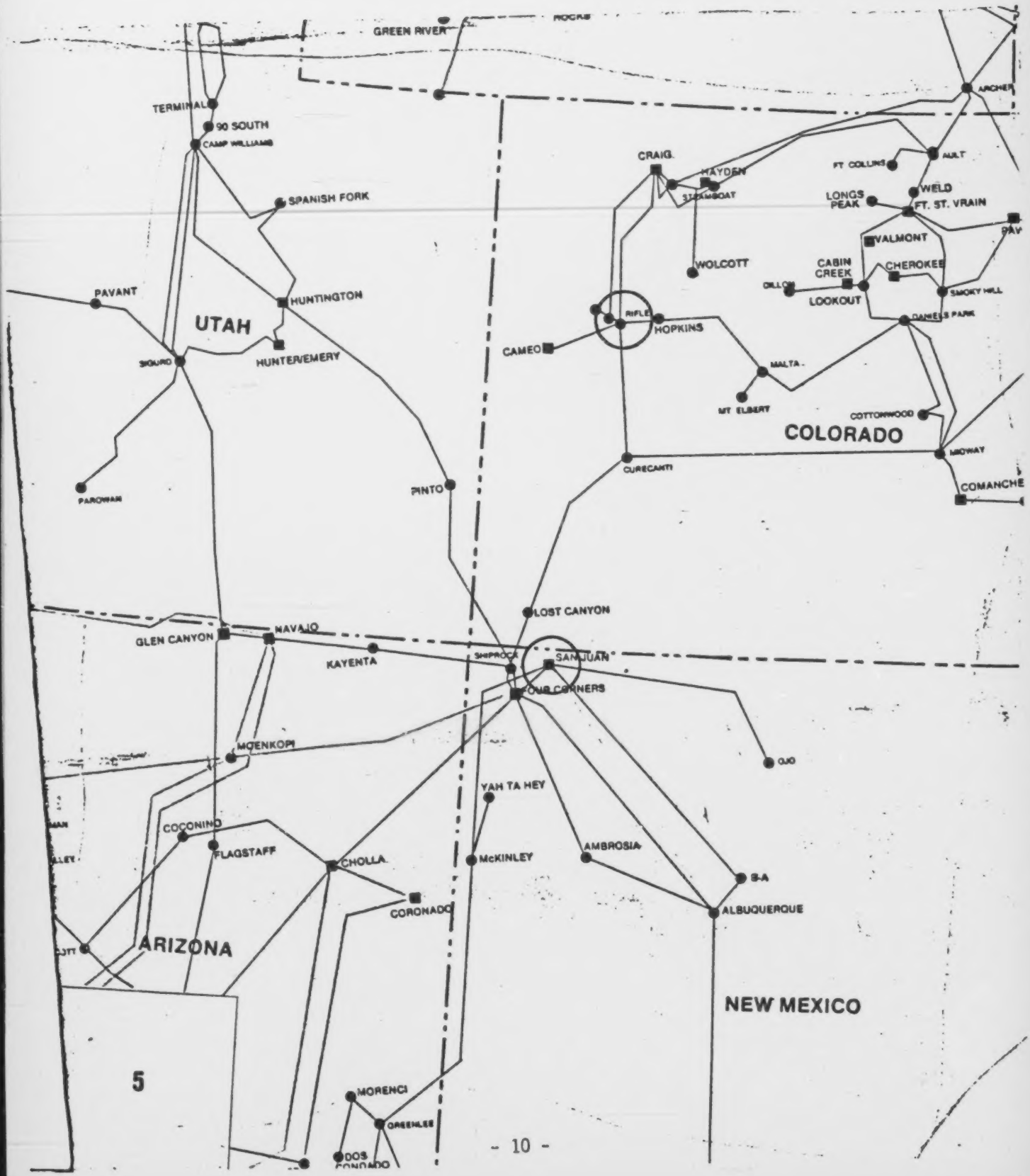
* Conductors are defined in terms of their circumference in thousands of circular mils (MCM) and the type of material used; i.e., aluminum conductor, steel reinforced (ACSR).

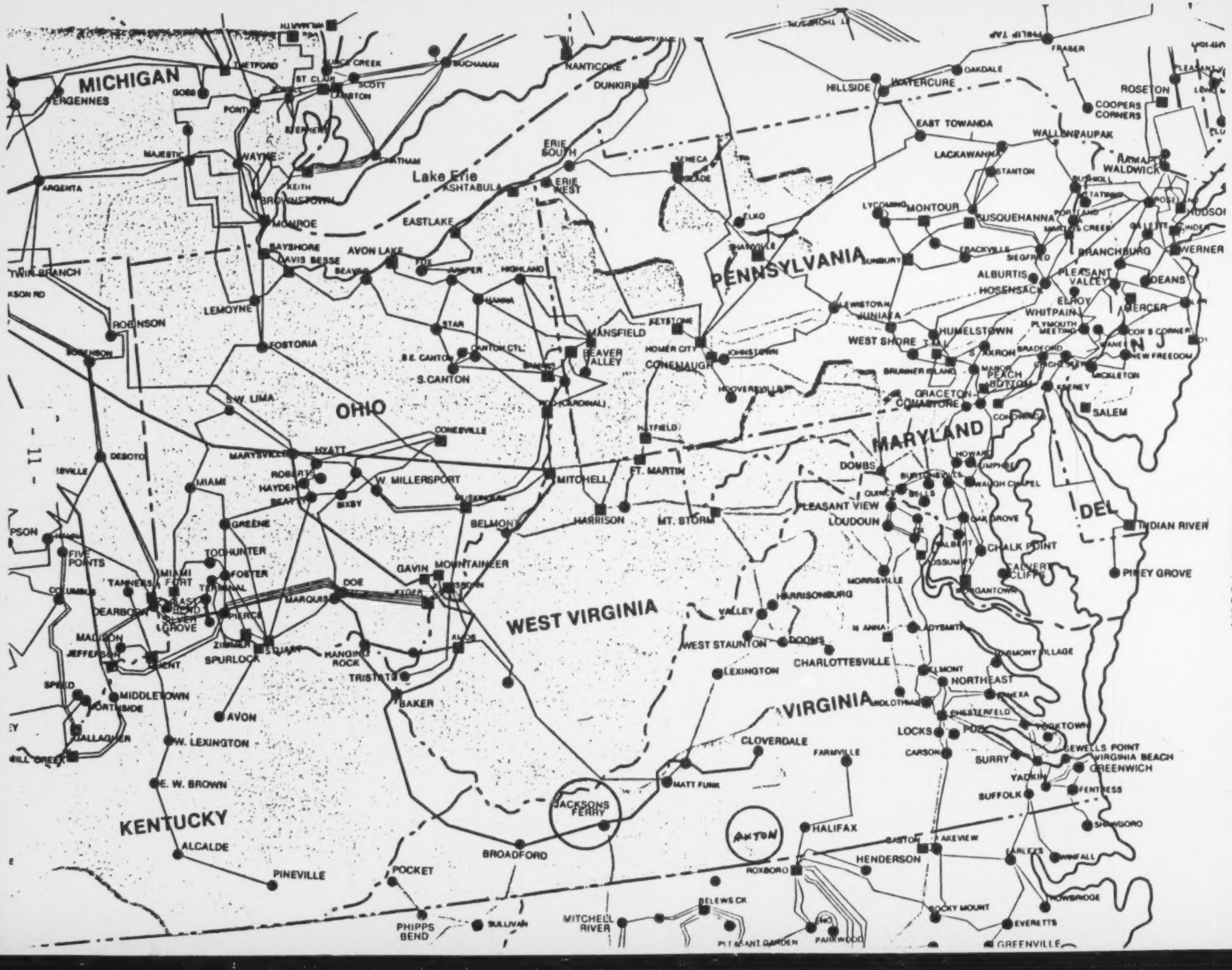
In some cases, the sequence of events will differ depending upon the utility's internal functioning, the requirements of the particular regulatory bodies involved, and the physical details of the line in question (existing right-of-way, existing terminal development, etc.).

APPENDIX A

LOCATION OF TRANSMISSION LINES STUDIED

RIFLE - SAN JUAN 345KV

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AXTON
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MOUNTAINEER
KANAWHA
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INDIAN RIVER
PINEY GROVE
LOUDOUN
DOUBS
LEESBURG
MORRISVILLE
HARRISONBURG
WEST STAUNTON
LOCKS
SURRY
GREENWICH
VIRGINIA BEACH
SEWELLS POINT
ROSETON
HILLSIDE
MONTOUR
SUSQUEHANNA
WALDWICK
BRANCHBURG
ALBURTIS
PLEASANT VALLEY
MERCER
SALEM
CONASTONE
GRACETON
PEACH BOTTOM
WEST SHORE
HUMMELSTOWN
JUNIATA
LACKAWANNA
EAST TOWANDA
WALLENPAUPAK
COOPERS CORNERS
FRASER
OAKDALE
MONTICORE
DUNKIRK
ERIE SOUTH
ERIE WEST
ASHTABULA
EASTLAKE
AVON LAKE
BAYSHORE
DAVIS BESSE
LEMOYNE
FOSTORIA
ROBINSON
S.W. LIMA
S.E. CANTON
S. CANTON
CANTON CTL.
STAR
HIGHLAND
HANNA
MARYSVILLE
HYATT
CONESVILLE
W. MILLERSPORT
HAYDEN
ROBERTS
MIAMI
DEBOLT
GREENE
TODHUNTER
FOSTER
MIAMI FORT
TANNERS
DEARBORN
FIVE POINTS
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MIDDLETOWN
AVON
W. LEXINGTON
E. W. BROWN
SPURLOCK
ZIMMER
PIERCE
MARQUIS
DOE
HANGING ROCK
TRISTATE
BAKER
ALOE
BELMONT
MITCHELL
KEYSTONE
HOMER CITY
JOHNSTOWN
HUNTINGDON
HOOVERSVILLE
KUTZTOWN
BRUNNER ISLAND
S. AKRON
BRADFORD
NEW FREEDOM
MICKLETON
KENNEY
WHITPAIN
PLYMOUTH MEETING
COOPERS CORNER
ELROY
HOSENSACK
DEANS
WERNER
SIEGFRIED
TRACKVILLE
SUNBURY
LEWISTOWN
LYCOMING
ELKO
SHAMOKIN
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PORTLAND
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CALVERT CLIFFS
CALBERT
OSSUMY
MORGANTOWN
ELMONT
NORTHEAST
RIVERA
CHESTERFIELD
MIDLOTHIAN
COLONY VILLAGE
N. ANNA
LADYSMITH
DOOMS
FARMVILLE
MATT FUNK
CARSON
POCOMOKE
POCOMOKE CITY
YADKIN
FENTRESS
SHAWBORO
EARLEYS
WINFALL
AKEVIEW
GASTON
PARKWOOD
PLEASANT GARDEN
BELEWS CK
SULLIVAN
TWIN BRANCH
ARGENTA
MAJESTIC
WAYNE
KEITH
BROWNSTOWN
MONROE
GOSS
PONTIAC
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SCOTT
LAWTON
BUCHANAN
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DETROIT
SPRINGFIELD
SPEED
GALLAGHER
HILL CREEK
JEFFERSON
ZANE
SQUAW
ALCALDE
BOSWELL
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CARTERSVILLE
CASCADE
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CLIFTON FORGE
COLONIAL HEIGHTS
COLUMBIA
CONCORD
CONCORDIA
CONNER
CRAIGSVILLE
CRANE
CRANES MILL
CRAWFORD
CRESCENT
CRESTWOOD
CRIMORA
CROZET
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CUSHAW
DANVILLE
DARBYTOWN
DARLINGTON HEIGHTS
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DAWSONVILLE
DEEP CREEK
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DEPOT
DERBY
DEWITT
DIAMOND HILL
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DOUGLAS
DOVER
DOWNEY
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DRIVER
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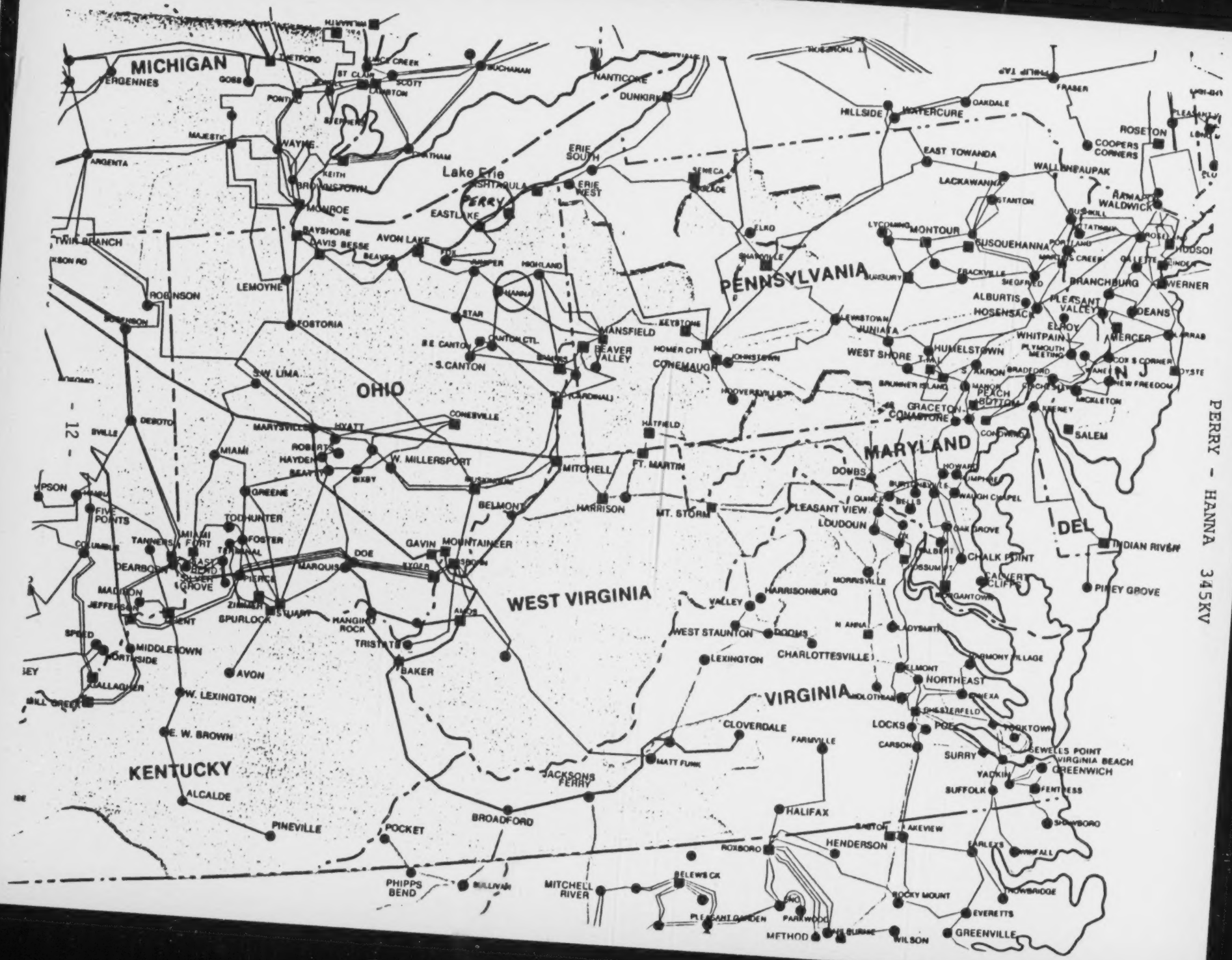
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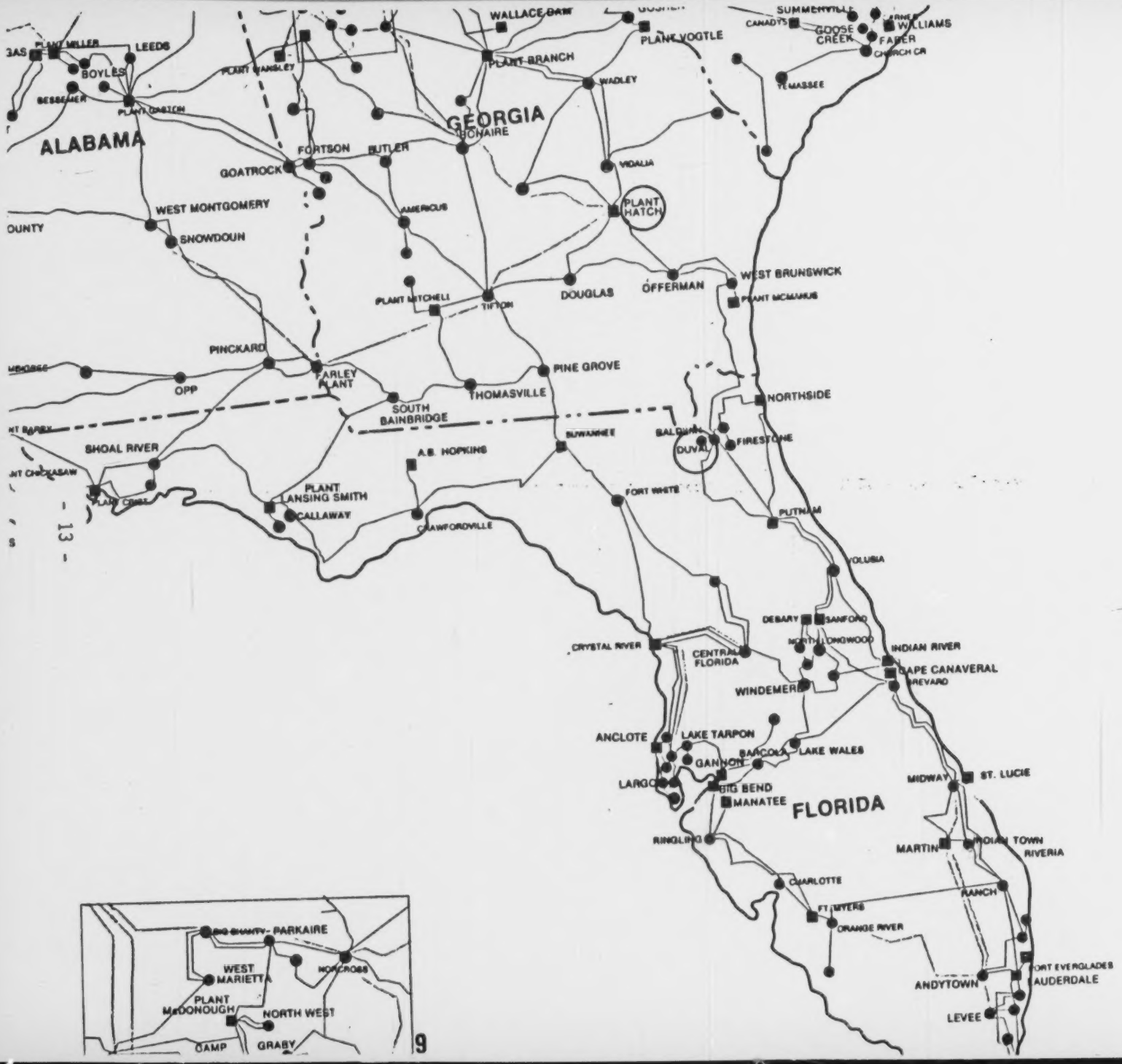

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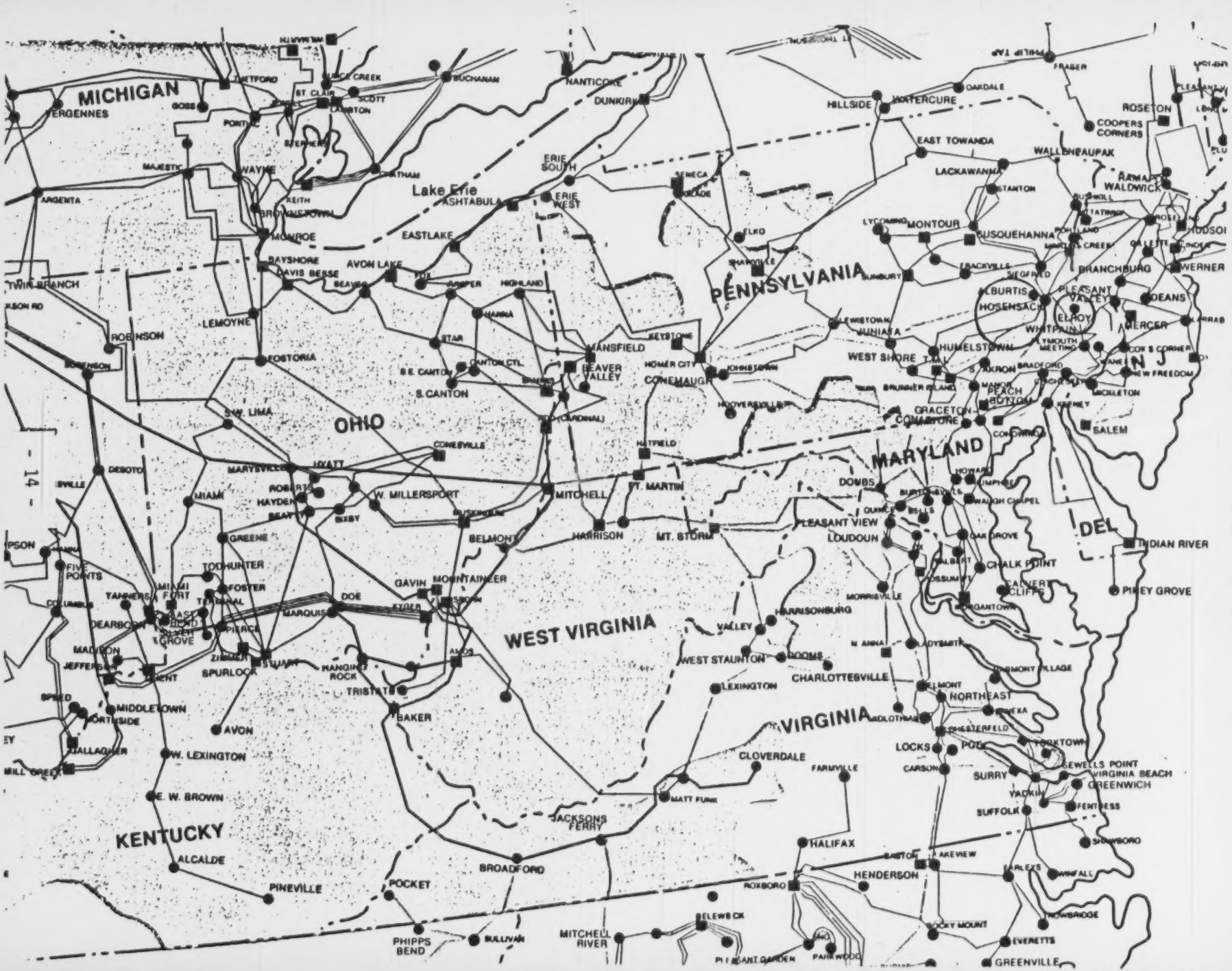
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ERIE WEST
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DAVIS BESSE
BEAVER
PORT
JUNIPER
HIGHLAND
HANNA
STAR
MANSFIELD
KEYSTONE
HOMER CITY
CONEMAUGH
JOHNSTOWN
BEAVER VALLEY
S CANTON
CANTON CTL
BE CANTON
CARDINAL
HOOVERSVILLE
ELKO
SHAWVILLE
LYCOMING
MONTOUR
SUSQUEHANNA
LACKAWANNA
STANTON
BRANCHBURG
WERNER
SIEGFRIED
SUNBURY
TRACKVILLE
ALBURTIS
PLEASANT VALLEY
HOSENSACK
ELROY
WHITPAIN
MEETING
MERCER
DEANS
LEWISTOWN JUNIATA
WEST SHORE
HUMMELSTOWN
S AKRON
BRADFORD
PEACH BOTTOM
GRACETON
CONASTONE
KREMEY
SALEM
NEW FREEDOM
MICKLETON
ROBINSON
LEMOYNE
FOSTORIA
SW. LIMA
DEBOTO
MARYSVILLE
HYATT
ROBERTS
HAYDEN
BEATTY
BIXBY
W. MILLERSPORT
MIAMI
CONESVILLE
HUNTFIELD
MITCHELL
ST. MARTIN
HARRISON
MT. STORM
BELMONT
DOMBS
PLEASANT VIEW
LOUDOUN
CHALK POINT
CALVERT CLIFFS
INDIAN RIVER
PINEY GROVE
GREENE
TODHUNTER
FOSTER
FIVE POINTS
TAPPANS
MIAMI FORT
EAST BEND
RIVER GROVE
PIERCE
DEARBORN
MADISON
JEFFERSON
GAVIN
MOUNTAINEER
DOE
MARQUIS
EXTER
MORRISVILLE
HARRISONBURG
VALLEY
WEST STAUNTON
BOONS
CHARLOTTESVILLE
LEXINGTON
N ANNA
LADYSMITH
ZIMMER
SPURLOCK
STUART
MANCHESTER ROCK
TRISTATE
AMOS
BAKER
SPEED
MIDDLETOWN
NORTHSIDE
GALLAGHER
AVON
W. LEXINGTON
E. W. BROWN
CLOVERDALE
FARMVILLE
MATT FUNK
JACKSONS FERRY
ALCALDE
PINEVILLE
POCKET
BROADFORD
PHIPPS BEND
SULLIVAN
MITCHELL RIVER
BELEWS CK
PLEASANT GARDEN
HALIFAX
ROXBORO
HENDERSON
GASTON
LAKEVIEW
ROCKY MOUNT
PARKWOOD
GREENVILLE
EVERETTS
SNOWBRIDGE
EARLEYS
WINFALL
SHOCCO
NORTHEAST
MIDLOTHIAN
CHESTERFELD
POE
LOCKS
CARSON
SURRY
YORKTOWN
SEWELLS POINT
VIRGINIA BEACH
GREENWICH
YADKIN
FENTRESS
SUFFOLK

APPENDIX B

RIFLE - SAN JUAN 345KV LINE

CASE STUDY

Rifle - San Juan 345KV line

This line will be jointly owned and constructed by Colorado-Ute Electric Association (CUEA), Public Service Company of Colorado (PSC) and the United States government under the Western Area Power Administration (WAPA). The 280 mile line is needed to serve CUEA member systems' loads and is an important link required to bolster the bulk power electric transmission system in western Colorado.

There are actually two separate segments of the line. One segment which will be built between Rifle and Grand Junction, Colorado will be owned by the three organizations cited above. The remaining segment between Grand Junction and San Juan, New Mexico will be owned only by CUEA and WAPA.

The line will be a single circuit installed on a tower designed to carry only a single circuit. It will be energized at 345,000 volts and cost approximately $125 million including towers, conductors, land for right-of-way, five intervening substations, and terminal equipment at each end of the line. However, construction costs for only the new line and terminal equipment (excluding the cost of the five substations) will range from $300,000 to $350,000 per mile depending upon the degree of difficulty of construction in mountainous areas.

The line was originally proposed for service during 1982. An extremely tedious certification process has caused this date to slip to at least 1985. If the 1985 in service date is achieved, it would have taken approximately seven years from the time the line was originally proposed until completion of construction with only twenty-four months of that time required for actual construction.

The initial step of the certification process for this line must be the completion of an Environmental Impact Statement (EIS) by the Rural Electrification Administration (REA) of the U.S. Department of Agriculture. The EIS is still in progress and cannot be completed until the final routing of the entire project is determined.

In spanning the 280 miles between Rifle, Colorado and San Juan, New Mexico, this transmission line passes through nine counties, state-owned land, U.S. Forest Service and Bureau of Land Management federally-owned land, and Indian reservation land. A special use permit must be obtained from each of the nine counties, the Colorado Public Utility Commission must issue a Certificate of Public Convenience and Necessity, land managers of each federal parcel must issue permits to construct a line across federal land, and agreements must be reached with each Indian tribe for the use of their land.

The present route and line configuration is the second proposed by the line builders. The first was opposed by environmental groups and not approved by the Colorado Public Utility Commission. Although the Public Utility Commission hearing examiner generally recommended that the line be approved, the Commission members did not feel that the project funding, including the federally guaranteed financing of WAPA's share of the line, was secure enough.

One problem plaguing the certification of this transmission line is the difference in points of view of the private land owners and the federal land managers: private entities generally feel the line should be built on public land and each federal land manager would prefer the line be built on private land.

An additional problem the line owners face is that the federal land managers would like any transmission facility which crosses federal land to do so only if all facilities ever required along that route are built with the initial line in question. In the face of rising costs of money and the need to show a need for any additions to the rate base, the utilities involved have been hard pressed to comply with the wishes of the federal land managers.

After the line has been approved by all required jurisdictions, CUEA must then set out to obtain easements to cross the many parcels of privately-owned land required for the right-of-way over the route approved. For example, obtaining a special use permit from a county merely grants the utility the right to construct a line in the county. However, the right to construct that line on a specific parcel of privately owned land within the county must be obtained from the individual private property owner.

APPENDIX C

JACKSON'S FERRY - AXTON 765KV LINE

CASE STUDY

Jackson's Ferry - Axton 765KV Line

This line is being proposed for installation by the Appalachian Power Company (APCo) who is a member of the American Electric Power System. It will extend approximately 72 miles connecting Jackson's Ferry substation in south central Virginia to the new 765/138KV Axton substation near Martinsville, Virginia.

The line will be a single circuit tower line, energized at 765,000 volts, installed on a new right-of-way. It is estimated to cost approximately $56 million for the line and towers and an additional $5.6 million for purchase of a right-of-way, bringing the total cost of the project to about $800,000 per circuit mile. These figures are in 1985 dollars for a 1985 in-service date. (Original estimates made in 1974 for a 1977 in-service date were approximately $400,000 per circuit mile.)

The certification of this line was performed in two segments: first, a determination of whether the line was needed at all; second, approval of the route selected for the right-of-way. On March 22, 1974 APCo applied to the Virginia State Corporation Commission (SCC) for approval of the need for the line. The SCC gave approval on July 5, 1974. In late 1974 APCo applied for approval of the right-of-way route. After extensive hearings the SCC issued a Certificate of Public Convenience and Necessity on January 4, 1978 granting approval of a right-of-way. The SCC ruling was appealed to the Virginia Supreme Court. However the original SCC decision was upheld and the route of the line was approved in October 1979.

This lengthy process would have normally resulted in the start of construction. However, the proposed and approved route resulted in the line extending over the Blue Ridge Parkway for approximately 2000 feet. Crossing this road required the approval of the National Park Service (NPS).

APCo applied for NPS approval on January 27, 1978. The original thinking of the NPS was that an Environmental Impact Statement (EIS) must be submitted for the entire 72 miles of the line. However, the NPS ultimately decided to consider only the 2000 feet of the line which crossed its jurisdiction and issued a permit for the crossing of the Blue Ridge Parkway on November 6, 1981.

This decision by the NPS was appealed by the "Citizens for the Preservation of Floyd County" on the basis that the Interior Department did not submit a sufficient EIS when it considered only the parkway crossing, and also, that the NPS did not consider the need for the entire line. On June 29, 1982 a judge ruled in favor of APCo and the NPS. However, on August 30, 1982 the intervenors filed an appeal with the Federal Appeals Court. The case is still pending; however, APCo expects another decision in its favor.

If the decision of the lower court is upheld and line approval is granted, the earliest this line could be placed in service is 1985 - eight years after the originally proposed date.

APPENDIX D

PERRY-HANNA 345KV LINE

CASE STUDY

Perry-Hanna 345 KV Line

The subject line will be jointly owned by the Cleveland Electric Illuminating Company (CEI) and the Ohio Edison Company (OE). Depending upon the ultimate route chosen, the line will be either 51 or 58 miles in length and is needed to deliver the generator output of the Perry nuclear plant and help relieve transmission overloads in northeastern Ohio.

The line will consist of double circuit, lattice steel towers with a single circuit installed for all but ten miles of the route. These remaining ten miles will consist of adding a second circuit to existing double circuit towers. The line will be three phase with two 954 MCM ACSR conductors per phase and energized at 345,000 volts. Approximately 75% of either route chosen for the line will be on new right-of-way. It is estimated that the total time required for construction will be four years. Cost estimates for both routes are as follows:

	Alternate 1	Alternate 2
Route length	58.1 miles	51.1 miles
Construction	$50,000,000	$45,000,000
Right-of-way	$ 7,000,000	$ 5,000,000
Terminal Equipment	$ 2,600,000	$ 2,600,000
TOTAL	$59,600,000	$52,600,000
$/MILE	$ 1,030,000	$ 1,030,000

The delay in the installation of the Perry-Hanna line does not appear to be the result of a single controversial issue. Rather the tedious certification process required by the State of Ohio has been the cause of the almost three year delay in the expected in service date of this line (1985 to 1988).

In Ohio certification of major electric facilities by the Ohio Power Siting Board (OPSB) is required for all major electric facilities on which construction was started after October 23, 1974. The Perry-Hanna line requires such a certification.

On November 9, 1977 a pre-application conference was held with the Power Siting Commission Staff and the Applicants' representatives, and waivers of specific requirements were discussed. On November 22, 1977 at its regular meeting the Commission granted the Applicants' request for a waiver of the Ohio Administrative Code that requires alternative transmission line routes to have no more than twenty-percent of their routes in common.

The Applicants submitted their Application for line certification on February 1, 1978, and additional data on July 5, and September 8, 1978 at the request of the Commission Staff. On July 2, 1979, the Application was certified as being complete. Proof of service of the Application on appropriate public officials and agencies, as required by law, was filed by the Applicants on August 8, 15, 20 and September 10, 1979. Proof of Public Notice was also filed on September 10, 1979.

Informational meetings were held by the Commission Staff on September 11, 1979 in Mentor, Ohio and on September 12, 1979 in Hiram, Ohio. Both of these locations are near the proposed line routes. The Secretary's Report, recommending the approval of a certificate with certain conditions, was released on December 26, 1979.

A public hearing on the project, chaired by the Administrative Law Judge, was held on February 18, 1980 in Middlefield, Ohio. The formal adjudicatory hearing started on February 19, 1980 and lasted through April 18, 1980 and resulted in the Administrative Law Judge issuing his opinion 14 months later on June 18, 1981.

On March 5, 1982, the Commission ruled on the project, denying a certificate on the basis that the Applicants had not adequately shown that the line would have minimal environmental impact on a local Amish community. The Applicants requested a rehearing to permit filing of an amended Application. On May 5, 1982, the Commission ruled to re-open the case. That ruling was appealed to the Ohio Supreme Court. A motion prohibiting the filing of an amended Application pending resolution of questions by the Supreme Court was requested on June 29, 1982 by the Counsel for the intervenors. This motion was granted by that Court on June 30, 1982, effectively suspending all action on the project. A Supreme Court ruling is expected in October 1982.

APPENDIX E

DUVAL (FLA.) - HATCH (GA.) 500KV LINES

CASE STUDY

Duval (Fla.) - Hatch (Ga.) 500 KV Lines

Historically, the electric power systems in the Peninsula of Florida have been inadequately interconnected (low transfer capacity in MW) to the eastern power grid. This inadequacy prevented the Peninsular Florida systems from importing more than 300 megawatts of electric power without risking a major system disturbance. As early as the early 1970's, the peninsular planning group recognized the need to increase the capability of these ties by building a 500 KV system within the state of Florida and interconnecting it to the 500 KV system in Georgia and Alabama. There was not sufficient economic justification for constructing these lines in the early 1970's and they were not planned to be placed in service until around 1990.

During 1979 it became obvious that the Southern Company would have coal generating capacity available for sale during the early to late 1980's. The Peninsular Florida Power Systems are predominately fueled by oil. During 1981 more than 50% of their electricity was generated using oil. The utilities in Florida were quick to recognize the potential savings which could be made due to the difference in price of the power available from the Southern Company and the power that would otherwise have to be generated within the state of Florida. These savings were large enough to be obvious not only to the utilities, but to the Public Service Commission and the legislature. The annual savings were estimated to be nearly $150,000,000 as a result of the initial 1200 megawatts of capacity which could be made available with the addition of two 500 KV interconnections between Georgia and Florida.

These savings, which were so much larger than the estimated $30 million cost of constructing the initial two single circuit 500 KV transmission lines and so obviously in the public interest, were given special regulatory treatment by the Florida state legislature and the Public Service Commission. These economic incentives resulted in the passage of the 1980 Transmission Siting Act in July of 1980. This act provided for a single hearing for the licensing of the first two extra high voltage transmission lines to be placed in service between Florida and Georgia. The act significantly reduced the environmental review required prior to approval of construction of these two transmission lines.

These transmission lines were a joint project between Georgia Power Company, a subsidiary of the Southern Company, Florida Power and Light Corporation and the Jacksonville Electric Authority. The segments of the lines between Hatch (Ga.) and the Georgia/Florida border was constructed and owned by Georgia Power Corporation. The portion of the line between the Florida/Georgia border and the Duval (Fla.) substation was built on a 50/50 ownership arrangement between the Jacksonville Electric Authority and the Florida Power and Light Corporation. The construction of the Florida portion of the line was supervised entirely by Florida Power and Light.

These specific lines were first conceived in the fall of 1979. In January of 1980, corporate approval was made for purchase of right-of-way for these transmission lines. The first of these lines was expected to be completed no sooner than May of 1983. In July of 1980, clearing of the substation site was begun. From August of 1980 through August of 1981, transmission right-of-way was acquired. In September of 1980,

site work was begun on the substation. By March of 1981, clearing of the right-of-way and access roads had begun. In May of 1981, electric substation construction was begun. In August 1981, line construction was begun. The first of the two 500 KV lines under construction was placed in commercial operation on April 15, 1982, with the second 500KV line placed in commercial operation on August 5th. Both dates well ahead of the originally expected in-service date.

The Duval (Fla.) - Hatch (Ga.) lines are two single circuit, 500KV transmission lines with steel lattice towers. The portion of each of these lines within the state of Florida was 36 miles. The budget estimate for these two transmission lines was $30 million. This included $13 million for the substation and $17 million for construction of both transmission lines. The utilities were fortunate in that during the period when these transmission lines were under construction, there was a surplus of transmission and substation equipment which enabled the utilities to negotiate a very good price for this equipment. This surplus also prevented any equipment delays. It is not likely that they would be able to build these transmission lines today nearly as cheaply or as quickly as they were during 1981 and 1982.

There were two factors which were very significant in enabling these lines to be constructed in such a short period of time. The first was the passage of the Transmission Siting Act in July of 1980. The second was the assignment of a senior vice president to this particular project to assist in the management of the entire project. His main objective was to keep the line project moving and to overcome any and all obstacles which might stand in the way of its completion.

This vice president also was responsible for negotiating the power sales agreements between Georgia Power Corporation and the JEA on behalf of Florida Power and Light.

The Georgia portion of these lines included two circuits which ran on separate right-of-ways. The first circuit was 90 miles long with a total cost of $35 million, approximately $4 million of which was for the substation. The second circuit was 106 miles long with a total cost of $40 million, again with $4 million for substation work.

Both circuits were first conceived of being built by the planning department during mid-1979. Budget approval was received for the first circuit in October 1979. Right-of-way acquisition took place between June 1980 and July 1981. Right-of-way clearing was begun in December 1980. The line construction itself began in July 1981 and was completed in April 1982.

The Hatch (Ga.) 500KV substation was in operation before these lines were conceived. The Hatch substation only required the addition of some protection equipment. This is in contrast to the Duval (Fla.) substation which was completely new. This is why there is a more than two to one difference in costs.

As with the Florida portion of the line, there was an ample supply of equipment and contractor personnel for the construction of the line so that no equipment delays were experienced. Contractors constructing the line were also given financial incentives for completion of the line at the earliest possible date.

The licensing situation and environmental requirements in Georgia are much less stringent than those of many other states in the U.S. A transmission line in Georgia does not require any environmental impact statement unless it is associated directly with the construction of a new power plant, it crosses a state park, or an environmentally protected area. A federal environmental impact statement is not required unless it crosses federal land or a national park. The 500KV circuits discussed here did not cross any of these areas. No environmental impact statement was therefore required with either the federal government or the state government for these transmission lines. Approval was needed on the part of several railroads for railroad crossing and the Army Corp of Engineers for the crossing of several federal highways and the St. Marys River (the Florida/Georgia border in this part of the states). None of these were major obstacles, however, and did not cause any delay in the construction of the line.

Acquisition of right-of-way was also eased by the fact that both transmission lines were routed through forest lands in southeastern Georgia. These forest lands were owned by only two or three large paper companies. This made it easier to negotiate the sale of land because only the few large companies and a few individuals whose farm properties were crossed by the lines were involved. The number of individuals that must be dealt with in the acquisition of right-of-way can become a significant factor in how long it takes to acquire the necessary right-of-way for a new transmission line.

Georgia Power Corporation had significant financial incentives to encourage them to build this line at the earliest possible time. The savings to Florida as discussed earlier were quite large and the incentive to the utilities and to the state commission was obvious. Georgia Power Corporation, because of the particular way in which the contracts were written and their relationship with their state commission, allowed the profits from the sale of energy and capacity to the Florida utilities to flow through directly to the stockholders of the company. This was a significant inducement to Georgia Power Corporation to complete this deal in the shortest possible time.

All parties felt that these lines represented the optimum amount of time in which a transmission line could be built. It combined the near elimination of environmental licensing requirements and the propitious timing of constructing the lines with regard to transmission and substation equipment supplies. It is not likely that transmission lines of this type could be built more quickly under any conceivable circumstances.

APPENDIX F

ELROY-HOSENSACK 500KV TRANSMISSION LINE

CASE STUDY

REGULATORY DELAYS AND LENGTHY LITIGATION PROVED COSTLY FOR ELROY-HOSENSACK 500 KV TRANSMISSION LINE

G. D. Paradis*
Philadelphia Electric Company

The Elroy-Hosensack 500 kV transmission line was completed and energized for testing on March 22, 1981 and was released for service March 23, 1981 after years of regulatory delays and extensive litigation at the home stretch.

Connecting into existing Whitpain to Branchburg (PSE&G) line, the line extends from Elroy Substation to Hosensack Substation (PP&L), a distance of 17.4 miles. The right of way width is 150 feet for the 12.7 miles adjacent to the Pennsylvania Power and Light Company's existing right of way and 200 feet for the remaining portion of the route.

The line is designed to operate at a nominal 500 kV and is supported by conventional lattice type, single circuit structures with aluminum tops and steel bases. The structural design of the tower is basically the same as that of the Keystone Project tower design.

The towers are designed to carry a single 500 kV circuit having two 2493 kcmil (1.821 inch diameter) ACAR conductors per phase with two 13 - #9 (.572 inch diameter) alumoweld static wires. This design allows for a radial ice loading of one inch on all wires together with a traverse wind loading of 8 pounds per square foot. In the construction of this line and the associated loop at Elroy Substation, 92 line towers were erected. The average span length for the line is 1020 feet, the longest being 1988 feet. Actually, there is nothing new or special about this line except it was the first one built after passage of the new PUC siting regulation and, therefore, demanded considerable attention in areas concerning the environment. Special consideration was given to the following: flood plain, soil erosion and sedimentation control, vegetation control and right of way clearing and restoration.

It might be of interest to review how the route evolved, what complications were encountered and the seemingly endless series of events that delayed completion of the project.

In early 1970, Metropolitan Edison, PP&L and PECO met in Allentown to discuss the routing for a new 500 kV line to be constructed between our Whitpain-Branchburg line and a 500 kV line being built by Metropolitan Edison from Three Mile Island to Hosensack. An area of over 100 square miles was studied and special attention was paid to the utilization of existing utility corridors in the area. By a consensus of the three companies, a preferred route was selected with two alternates. The preferred route would extend from Bechtelsville in Berks County to Elroy in Montgomery County - approximately 18 miles. A service date of June 1, 1974 was established.

* This discussion was submitted by Mr. Paradis at the I.E.E.E. Winter Power Meeting in Atlanta, Georgia in 1981.

By 1971 a decision was made by our company to get involved in open planning and, since the line was mostly in Montgomery County, contact was made by our officials with the Montgomery County Commissioners.

As a result of this meeting, we were instructed to work with the Montgomery County Planning Commission (MCPC) in terms of assessing the need for the line and its best possible routing. From the fall of 1971 to the spring of 1973, approximately 40 meetings were held with officials of the various townships and counties that might be affected by the new line, including Bucks and Lehigh Counties, with MCPC being the lead agency. During this time, Montgomery County engaged the Franklin Institute to make a study relative to the need for the line together with construction costs and technical aspects relating to different types of structures. The Institute report was positive in all respects but they did not consider the routing.

By the middle of 1972 the MCPC, although not too enthusiastic, felt the best route was our preferred route between Bechtelsville and Elroy. However, it was at this time that a suggestion was made by the county that the locations of the two terminals be re-evaluated.

This was done and Elroy was retained as the terminal site on the Branchburg line. An alternate site preferred by the county would have extended the transmission line 1.3 miles, cost an additional million dollars and additional land for the substation would have had to have been acquired from a property owner who was strongly opposed to the installation.

As for the Bechtelsville site, it became apparant that Hosensack was the favorite for the western terminal provided a route could be developed into Hosensack adjacent to an existing PP&L right of way. The problems with this alternate plan were the numerous dwellings adjacent to the right of way. We were able to get options on 13 of the 15 dwellings, and crossings of the existing PP&L transmission line were kept to a minimum. This provided us with a viable condemnable route between Elroy and Hosensack. The service date was changed to June 1, 1975.

In 1973 we obtained options on all required dwellings so negotiations began in earnest over the entire 17.4 mile route. We were unable to come to agreement with approximately 25 property owners, most of whom lived in Franconia Township. Condemnation proceedings to acquire the unsettled properties began in January 1974 and concluded in 1975. On May 17, 1978 (entered June 5, 1978), the PUC granted us appropriate certificates of necessity. To complete the condemnation, bonds were served on the property owners including Mr. Goadby and preparation could be made to begin.

However, construction was delayed further due to the enactment by Pennsylvania PUC of new rules and regulations concerning the siting and construction of transmission lines. Basically, this requires utilities to apply to the PUC for their approval of all aerial transmission lines operating above 100 kV. We applied for a waiver of these rules as they applied to Elroy-Hosensack on June 16, 1978 and our petition was denied by the PUC on August 24, 1978. Franconia Township strongly objected to the wiaver on the basis of environmental impact and safety of the line.

On November 22, 1978, the siting application was filed with the PUC in conformance with these new regulations. A pre-trial conference was held January 26, 1979 and hearings were held and completed on June 28 and 29,

1979. Not until December 21 - six months later - was certification of the line issued by the PUC. Construction was finally started January 14, 1980 with a service date of February 1, 1981.

The next and last major obstacle was a property owner named Albert T. Goadby.

From 1972 to 1980, intermittent negotiations were carried on with Mr. Goadby or his attorney. He has had three different attorneys during this period and, before he engaged his last attorney in 1980, he had come to a tentative agreement for the right of way needed. An agreement was prepared and submitted to Mr. Goadby and he informed us that he wanted someone to review the papers before he signed it. We were contacted in April by Mr. Romano who said he represented Mr. Goadby.

On May 13, 1980 after ignoring his right to appeal the PUC's decision of May 17, 1978 and failing to voice his objection during the hearings before the PUC in June 1979, Mr. Goadby, who is located in the 12th mile of the line, denied entrance of our surveyors on his property and initiated the first of an extensive series of court proceedings. He then filed suit in Montgomery County Court of Common Please alleging that PECO had acted in violation of Pennsylvania law in acquiring his property. His motion for a preliminary injunction was denied and the complaint was dismissed. Subsequently, complaints were filed in Commonwealth Court and State Supreme Court; all were denied on the basis that Goadby had failed to show that the harm that would result from construction of the line outweighed the public's and PECO's need for the line.

Undaunted, Goadby then attacked the line from the safety aspect claiming that electrostatic and electromagnetic fields would render his house unliveable and would be injurious to his health. On September 29 and 30, 1980, Judge Newcomer, U.S. District Court for the Eastern District of Pennsylvania, heard Goadby's request for an injunction. Dr. Marino testified for Goadby and Dr. Miller from Rochester University testified for PECO along with other witnesses from PECO. On October 2, 1980, Judge Newcomer issued a preliminary injunction against PECO preventing construction activities on the Goadby property.

Judge Gibbons, Third Circuit Court of Appeals, overturned Judge Newcomer's decision on October 17, 1980. Three days later, Justice W. J. Brennan, Jr., U. S. Supreme Court, overturned Judge Gibbons' decison; then another three days later, he reversed his own decision and, with some limitations, gave PECO the right to build the line.

In the meantime, the wire stringing operation had progressed and conductors were strung up to the Goadby property and tied to a set of temporary ground anchors. At this point, we had a choice of stopping the stringing or skipping a couple of spans and continuing. Since court approval appeared imminent, we decided to stop.

Work began at Goadby's on October 28, 1980 after sheriff's deputies served Mr. Goadby with a writ of possession issued by Judge Tredinnick of Montgomery County Court. However, on the same day, Goadby appealed to the Commonwealth Court and Judge McFail issued a writ of prohibition which stopped work. At this stage, we decided to skip over the property,

install a set of temporary anchors and resume stringing toward Hosensack. Permanent dead end bodies were installed on all conductors at the temporary ground anchors and security guards were hired to protect the anchors. Subsequently, a three-judge panel, Commonwealth Court, heard arguments on Judge McFail's injunction and, on November 26, 1980, ruled that the injunction should never have been issued. Meanwhile, we were still in need of a writ of possession for police protection to allow us to clear the Goadby property. Since Goadby originally threatened to shoot anyone entering on his property, we felt it unwise for our construction people to attempt working there without police protection.

Judge Tredinnick, having been harassed by Goadby's lawyers, disqualified himself and Judge Davenport was assigned to the case. Judge Davenport promptly claimed that he had no jurisdiction over the writ of possession. We then petitioned the Commonwealth Court.

Goadby filed for re-hearing in Third District Court of Appeals and was denied. He also appealed to the Pennsylvania Supreme Court and was denied. On March 3, 1981, the court ordered Montgomery County Court to issue to PECO a writ of possession which was received on the 6th. Construction resumed on March 9; the line was completed March 17 and energized March 22, 1981.

The delay of service date had considerable financial impact on the company. The financial penalties are categorized as construction costs and non-construction or system costs. They can also be separated into costs associated with litigation (Mr. Goadby) and those associated with regulatory delays. Litigation penalties include both construction and system costs whereas regulatory delays involve only system costs.

The construction costs are direct charges incurred as a result of delaying service date over and above the contract to complete construction of the line.

These charges included:

1. Additional set of ground anchors	$ 9,161
Ground anchor reinforcement	2,250
2. Installation of permanent dead end fittings	
Labor	3,296
Material	1,120
3. Wire crews and equipment stopped from production work on October 23; returned to production work October 31	34,809
4. Cost of 24-hour guard service at temporary ground anchors adjacent to Goadby property. 23 weeks at $5,096	117,208
5. Wire crews and equipment - return to Goadby property to complete construction, performing aerial splicing of conductors	137,441
Total	$305,285

The non-construction charges from February 1 to March 23, 1981 total approximately $243,000 per week for seven weeks, or $1,701,000. Broken down into components, these system costs are:

Economic power interchange foregone	$116,000/week
Increased transmission line losses	95,000/week
Increased allowance for funds used during construction	32,000/week
Total	$243,000/week

The total cost of the project including Elroy Substation was estimated to be 15 million dollars and the penalty of the delay due to litigation increased the cost by over two million dollars or 13%. The system costs due to regulatory delays from 1975 to 1980 were estimated to exceed 15 million dollars.

We have not yet settled with Goadby for his property as well as ten other properties along the right of way.